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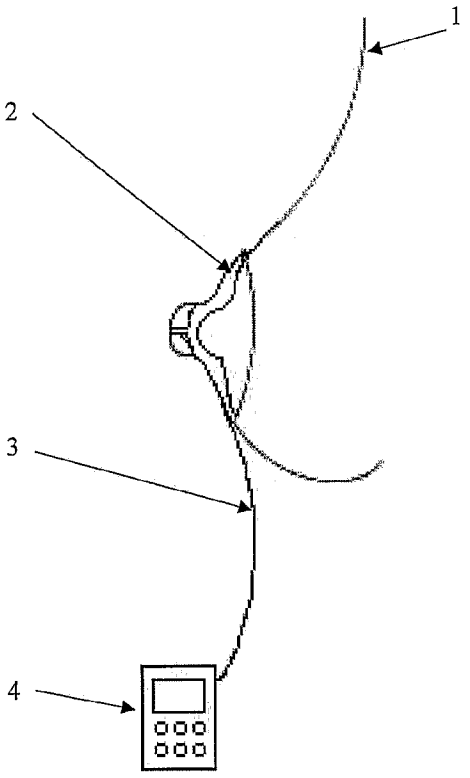
(54) Title: APPARATUS FOR DETERMINING TIIE AMOUNT OF MILK BREAST-FED TO A BABY BY CONVECTIVE HEAT TRANSFER



(57) Abstract: The apparatus for determining the amount of milk breast-fed to a baby by convection heat transfer includes a nipple shield, a tube and a thermal dilution gauge. On the nipple region of a mother, the nipple shield is mounted. Then, the tube is used to pass milk to the baby. The amount of milk passing through the tube is measured by the thermal dilution gauge.

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Apparatus for Determining the Amount of Milk Breast-Fed To a Baby by Convective Heat Transfer

Introduction and Background

This invention relates to baby care products and methods and more particularly to apparatus to determine the volume of human milk breast-fed to a baby.
To determine the volume of milk consumed by a baby during breast- feeding sessions, it is known to weigh the baby before the session as well as during and immediately after the session. This is a cumbersome process and the scales required are rather sensitive and thus expensive.

Object of the Invention

Accordingly, it is an object of the present invention to provide apparatus and a method with which the amount of milk may be determined and with which the applicant believes the aforementioned disadvantages may at least be alleviated.

Summary of The Invention

According to the invention there is provided apparatus for determining the amount of human milk supplied to a feeding baby during a breast-feeding session, the apparatus comprising:
A nipple shield adapted to be mounted on the nipple region of a breast of a mother; a tube or tubes defining an outlet through which milk passes to the feeding baby; and a thermal dilution gauge to measure the amount of milk passing through the outlet.
The nipple shield may be nipple-shaped and may be made of silicon rubber or any other suitable material.
The tube may be made of stainless steel, rigid plastic, or any other suitable material.
The thermal dilution gauge may comprise a heater and two resistive temperature detectors (RTD), or only two RTD, which can be mounted outside or inside the tube/s, as separate components or as one chip. Electronic circuitry, a data communication cable, or electromagnetic transmitter, connecting the thermal dilution gauge to the CPU and/or display unit, may be mounted and/or integrated on the nipple shield.
The display means may comprise a liquid crystal display, and/or may be adapted to print a graphical representation of data received from the thermal dilution gauge.
The display means may comprise switches for entering data (e.g. the age of the baby, etc.) or for selectively display the amount of milk per session, the accumulating amount of milk in several sessions, and previously consumed milk (memory switch).

Brief Description of the Accompanying Diagrams

The invention will now further be described, by way of example only, with reference to the accompanying diagrams wherein:

Figure 1 is a diagrammatic illustration of the apparatus according to the invention connected to the breast of a breast-feeding mother;
Figure 2 is a diagrammatic cross section of the nipple shield, illustrating the construction of the apparatus.
Figure 3 is a view of the tube, partially cross-sectioned, mounted with micromachined thermal dilution gauge, according to the invention;
Figure 4 is an isometric view of one of the suggested micromachined thermal dilution gauges, according to the invention.
Figure 5 is a diagram of the two possible arrangements of the thermal dilution gauge, and its control circle.

Description of Preferred Embodiments of The Invention

Apparatus for measuring the volume of human milk breast-fed to a baby (not shown) is generally designated by the reference numeral 2 in figure 1.

The apparatus comprises a nipple shield 2 made of three separate layers of silicon rubber 5,6 and 8. As shown in figure 2, a tube 9 is mounted in the nipple shield 2. As shown in figure 3, the thermal dilution gauge 11 presented in fig. 4 as a micromachined chip, is mounted on the tube as a part of the tube wall.
The electronic circuitry, a data communication cable 3 in figure 1, or electromagnetic transmitter, connecting the thermal dilution gauge to the CPU and/or display unit 4 in figure 1, are preferably mounted and/or integrated in the nipple shield 2.

In use, the nipple shield 2 is mounted on the breast 1 of a mother. The feeding baby (not shown) is allowed to feed through the nipple shield. The milk is allowed to flow through holes 7 in the inner layer 6 of the shield. The milk is temporarily accumulating in the space between layers 6 and 8. the milk then flows through the tube 9. The volume of milk taken in by the baby is measured by the thermal dilution gauge 11.

In Fig. 3, all or part of the milk flow 12 passes through a precision manufactured tube 9. Heat is applied to the milk flowing through the tube via a heater 14. The detectors 13 and 15 only sense the flow temperature. When there is no flow, the temperatures measured by the two detectors are the same (T1=T2). When the molecules of the milk pass through the upstream detector 13 they carry away a certain amount of heat and thus lowering the detector's temperature (T1). This process is repeated at the downstream detector 15 (T2) but less heat is transferred from the downstream detector due to the flow's having been preheated by the heater. The temperature differential (T2-T1) between the two detectors is measured in a Wheatstone bridge circuit 16 in fig. 5, and amplified by an amplifier 17.

In fig.5, two arrangements of the gauge are presented. The one on the right includes a heater 14, and its functionality was described above. The one on the left shows an arrangement without a heater. When this arrangement is applied, according to this invention, the detectors have a dual function: to both heat and sense the flow temperature. When the molecules of the milk pass through the upstream detector 13 (T1), they carry

away a certain amount of heat. This process is repeated at the downstream detector 14 (T2) but less heat is transferred from the downstream detector due to the flow's having been preheated by the first detector. The temperature differential (T2-T1) between the two detectors is measured in a Wheatstone bridge circuit 16 in fig. 5, and amplified by an amplifier 17.

In both arrangements, since the temperature difference between the two detectors is directly proportional to the mass flow of the milk, a highly accurate and repeatable flow measurement is obtained.
A correlation factor is typically used to relate the calibration of water to the milk. This factor is derived experimentally or from the milk density and coefficient of specific heat:

The volume of the milk is displayed on the display 4. The display may also comprise switches for entering data (e.g. the age of the baby, etc.) or for selectively display the amount of milk per session, the accumulating amount of milk in several sessions, and previously consumed milk (memory switch).

Thus, the apparatus according to the invention provides the mother in real time with an indication of the volume of milk taken in by the feeding baby. It would accordingly no longer be necessary to follow the cumbersome weighing process hereinbefore described. It will be appreciated that there are many variations in detail on the apparatus and method according to the invention, without departing from the scope and spirit of the appended claims.

Claims:

1. Apparatus for determining the amount of human milk supplied to a feeding baby during a breast-feeding session, the apparatus including:
   A nipple shield adapted to be mounted on the nipple region of a breast of a mother;
   A tube through which milk passes to the feeding baby; And a thermal dilution gauge to measure the amount of milk passing through the tube.
2. An apparatus as claimed in claim 1 wherein the nipple shield is nipple-shaped and made of silicon rubber.
3. An apparatus as claimed in claim 1 or claim 2 wherein the thermal dilution gauge includes a heater and two resistive temperature detectors (RTD), or only two RTD, which can be mounted outside or inside the tube/s, as separate components or as one chip.
4. An apparatus as claimed in claim 1 or claim 2 wherein an electronic circuitry, a data communication cable, or electromagnetic transmitter, connecting the thermal dilution gauge to the CPU and/or display unit, may be mounted and/or integrated on the nipple shield.
5. An apparatus as claimed in any one of the preceding claims wherein the thermal dilution gauge is connectable via a data communication cable or electromagnetic transmitter to display means.
6. An apparatus as claimed in claim 5 wherein the display means includes switches for entering data or for selectively display the amount of milk per session, the accumulating amount of milk in several sessions, and previously consumed milk.
7. A method of determining the amount of human milk supplied to a feeding baby during a breast feeding session, the method comprising the steps of providing a thermal dilution gauge between a breast of a mother and a mouth of the feeding baby, monitoring the amount of milk supplied, and displaying the amount of milk supplied.
8. A nipple shield adapted to be mounted on a nipple region of a breast of a mother, the nipple shield defining an outlet through which milk may pass to a sucking baby, the nipple shield including or being connectable to a thermal dilution gauge to measure the amount of milk passing through the outlet.
9. An apparatus for determining the amount of human milk supplied to a feeding baby during a breast-feeding session substantially as herein described with reference to the accompanying diagrams.
10. A method of determining the amount of human milk supplied to a feeding baby during a breast-feeding session substantially as herein described with reference to the accompanying diagrams.
11. A nipple shield substantially as herein described with reference to the accompanying diagrams.
12. A thermal dilution gauge substantially as herein described with reference to the accompanying diagrams.

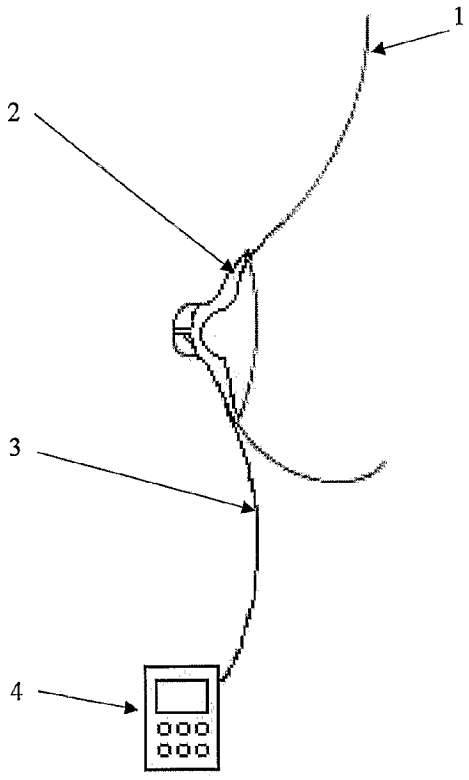

Figure 1

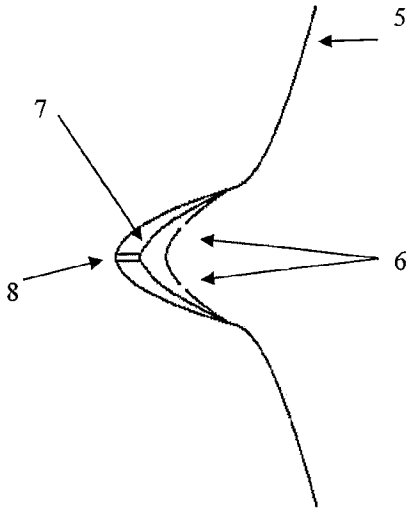

Figure 2

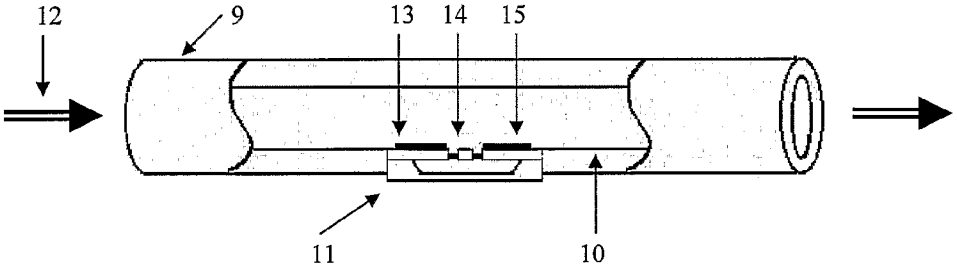

Figure 3

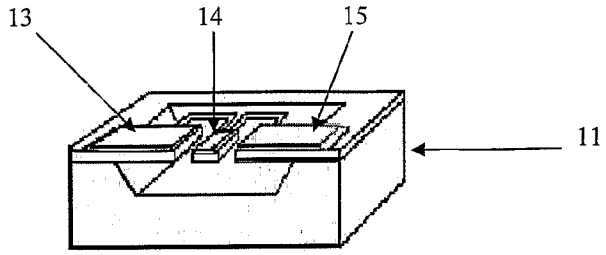

Figure 4

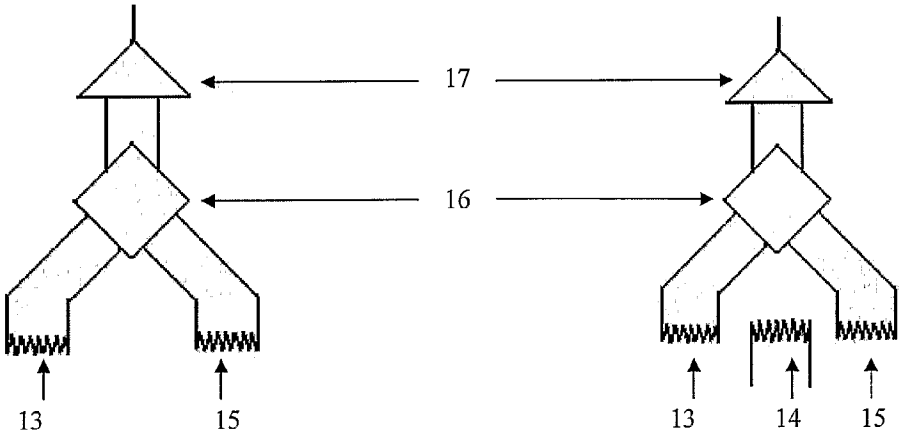

Figure 5